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High-Performance Data Acquisition and Beamline Control: Current Capabilities and Future Needs

M.L. Rivers

Center for Advanced Radiation Sources, University of Chicago, Argonne, IL 60439, USA

Operating synchrotron beamlines efficiently demands minimizing the overheads and delays during data acquisition. Modern detectors are capable of very high data collection rates but are often run at lower rates than the beamline X-ray photon flux would allow because of inappropriate data collection schemes. As X-ray sources, beamline optics, and detectors continue to improve, this mismatch will only get worse.

This talk will discuss current solutions to on-the-fly data collection that minimize the overheads, so that data collection speeds are limited only by the X-ray flux. These solutions include complex coordinated motions and continuous detector acquisition. Examples from X-ray diffraction with the Pilatus detector and X-ray spectroscopy with the XIA xMAP will be presented. With the Pilatus, we are currently able to collect 200 frames per second while moving a 6-circle diffractometer in a complex nonlinear trajectory. With the XIA xMAP, we can stream 4,000 spectra per second from a quad silicon drift diode detector (1,000 pixels per second) with collection coordinated with sample stage motion. Both of these techniques fundamentally change the type of experiments that can be performed.

In the future, an integrated beamline will require even tighter and more complex coordination than is currently possible. For example, continuous data acquisition will need to accommodate continuous motion of the undulator gap, monochromator, and sample. The hardware and software requirements for such experiments will be discussed.